

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
31 May 2001 (31.05.2001)

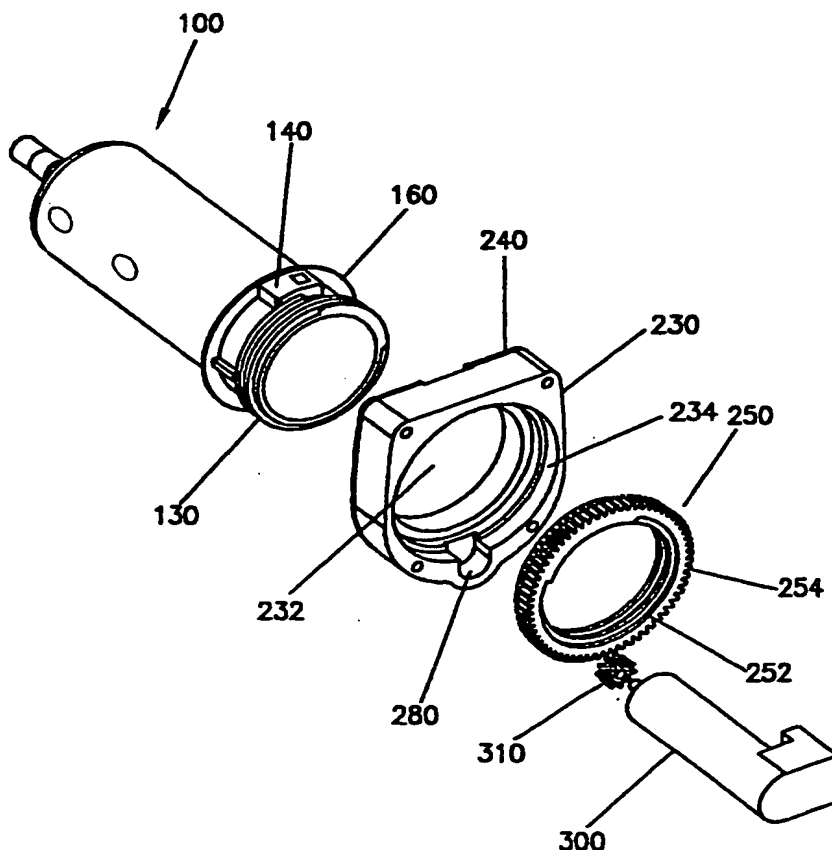
PCT

(10) International Publication Number
WO 01/37905 A2

- (51) International Patent Classification⁷: A61M 5/00 (74) Agent: BRADLEY, Gregory, L.; Medrad, Inc., One Medrad Drive, Indianola, PA 15051 (US).
- (21) International Application Number: PCT/US00/32271
- (22) International Filing Date: 21 November 2000 (21.11.2000)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data: 09/448,835 24 November 1999 (24.11.1999) US
- (71) Applicant: MEDRAD, INC. [US/US]; One Medrad Drive, Indianola, PA 15051 (US).
- (72) Inventor: REILLY, David, M.; 2318 Middle Road, Glenshaw, PA 15116 (US).
- (81) Designated States (*national*): AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.
- (84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: INJECTORS, INJECTOR SYSTEMS, SYRINGES AND METHODS OF CONNECTING A SYRINGE TO AN INJECTOR



(57) Abstract: A syringe includes an elongated body, a mounting member positioned on a rear portion of the body, and a plunger moveably positioned within the body of the syringe. An injector includes a housing and a retainer associated therewith. The retainer is adapted to cooperate with the mounting member to releasably retain the syringe on the injector. The retainer preferably includes a powered loader adapted to move the mounting member and the retainer into engagement to securely connect the syringe to the injector. The injector further includes a powered drive member disposed in the housing. The drive member is adapted to engage and control the movement of the plunger.

WO 01/37905 A2



Published:

— *Without international search report and to be republished upon receipt of that report.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

INJECTORS, INJECTOR SYSTEMS, SYRINGES AND METHODS OF CONNECTING A SYRINGE TO AN INJECTOR

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BACKGROUND OF THE INVENTION

The present invention relates to injectors and injector systems, and, more particularly, to injectors and injector systems in which a syringe is connected to or loaded upon the injector in a powered or manual manner.

10 A number of injector-actuated syringes and powered injectors for use in medical procedures such as angiography, computed tomography, ultrasound and NMR/MRI have been developed. For example, U.S. Patent No. 4,006,736 discloses an apparatus for injecting fluid into the vascular system of a human being or an animal. Likewise, U.S. Patent No. 4,677,980 discloses an angiographic injector and syringe wherein the
15 drive member of the injector can be connected to, or disconnected from, the syringe plunger at any point along the travel path of the plunger via a releasable mechanism. Each of the injectors disclosed in U.S. Patent Nos. 4,006,736 and 4,677,980 includes a pressure jacket that is breach or rear loaded with a syringe.

U.S. Patent No. 5,300,031 discloses an injector system in which a syringe is
20 connected to a pressure jacket of an injector through an open front end in the pressure jacket. The injector system of U.S. Patent No. 5,300,031 permits replacement of a syringe without retraction of the syringe plunger drive or disconnection of injection tubing connected to the syringe.

A front-loading syringe and injector system is disclosed in U.S. Patent
25 No. 5,383,858, the contents of which are hereby incorporated by reference. The syringes disclosed in U.S. Patent No. 5,383,858 can be securely front-loaded directly and accurately on the injector or on a pressure jacket attached to the injector, thereby facilitating the loading-unloading operation as compared to prior systems. In the front-loading system of U.S. Patent No. 5,383,858 and other currently available front loading
30 systems, a user manually aligns the syringe in a desired orientation relative to the injector and manually inserts and locks the syringe in place.

In the system of U.S. Patent No. 5,383,858, for example, an interlocking, releasable mechanism is activated and released upon proper axial and radial alignment

and subsequent manual rotation of a rearward portion of a syringe relative to a front wall of the injector housing. In one embodiment, the releasable mechanism includes slots on the front wall of the housing for receiving retaining flanges on the rearward end of the syringe. The syringe is manually rotatable to engage the retaining flanges with associated or cooperating flanges on the injector mounting mechanism. The releasable mechanism also includes an annular sealing member on the injector housing front wall against which a resilient annular sealing member or flange on the syringe becomes seated as the syringe is positioned on the mounting mechanism. The resilient annular sealing member and the retaining flanges on the syringe receive the flanges on the injector mounting mechanism therebetween with an interference fit.

The syringe plunger of U.S. Patent No. 5,383,858 must be appropriately axially and radially positioned relative to the injector drive member or piston during loading of the syringe upon that injector system so that rotation of the syringe during loading will also cause engagement of the drive member and the syringe plunger.

Although front-loading syringes represent a significant advancement in the area of injector-actuated syringes and powered injectors for use therewith, the loading and unloading procedures therewith require operator time and involvement to ensure secure engagement. For example, the operator must ensure that the syringes of current front-loading systems are first properly aligned with and then securely connected to the injector, and that the plunger is engaged by the injector drive member. These steps can require time and dexterity as a result of, for example, alignment requirements, awkward and complex motions and close design tolerances. In many cases the injector may also be positioned so that it is difficult for the operator to access the injector to load a syringe thereon. Moreover, injectors are typically not securely anchored and can move during syringe loading, further complicating loading of a syringe thereon.

It is very desirable to develop new syringes, injectors, injector systems and methods to reduce operator time and involvement in loading syringes onto injectors and/or in connecting syringe plungers to injector drive members, while ensuring secure engagement between the syringe (including the syringe plunger) and the injector.

SUMMARY OF THE INVENTION

The present invention provides improved injectors, injector systems, syringes and methods in which the syringe is loaded upon and/or unloaded from the injector in a powered or manual manner. The loading/connecting features of the present invention greatly simplify the process of loading a front-loading syringe onto an injector and free valuable operator time to accomplish other tasks.

The powered loading features of the present invention also provide greater confidence of proper and secure engagement of the syringe to the injector and/or the syringe plunger to the injector drive member. Moreover, because the loading procedure is powered, tighter tolerances can be designed into the mounting and retaining mechanisms of the present invention than with previous front-loading systems in which tolerances were limited or loosened to facilitate manual loading. The tighter tolerances of the present invention substantially reduce or eliminate play or movement of the syringe after connection thereof to the injector, thereby facilitating more accurate control of the injector.

In one aspect, the present invention provides an injector for injecting a fluid from a syringe. The syringe includes an elongated body and a mounting member positioned on a rear portion of the body. The syringe further includes a plunger moveably positioned within the body of the syringe. The injector includes a housing having a front wall and a retainer on the front wall. The retainer is adapted to cooperate with the mounting member to retain the syringe on the front wall of the injector. Preferably, the syringe is releasably retained upon the front wall of the injector. The retainer includes a powered loader adapted to bring the mounting member and the retainer into secure engagement to securely connect the syringe to the injector. The injector further includes a powered drive member in the housing. The drive member is adapted to engage the plunger and control the movement of the plunger.

The mounting member of the syringe may be formed integrally with the remainder of the syringe in, for example, a polymer molding procedure. Alternatively, the mounting member may be formed separately from the syringe and attached thereto. For example, an adapter including the mounting member can be

fabricated to be separate from and attachable to a syringe body. The adapter can, for example, be designed to accept a syringe, such as disclosed in U.S. Patent No. 5,383,858, to adapt that syringe or other syringes for use in the present invention. Preferably, the adapter is releasably connectible to the injector. The adapter is also
5 preferably releasably connected or attached to the syringe.

Likewise, syringes for use in the present invention are readily adapted for use with other injectors through use of an adapter. Such an adapter can, for example, be used to load a syringe of the present invention on an injector as disclosed in U.S. Patent No. 5,383,858.

10 In several embodiments, the powered loader of the present invention moves one or more components of the retainer to engage the mounting member and to bring the mounting member and the retainer into secure connection, thereby securely connecting the syringe to the injector. For example, the mounting member may include threading and the retainer may include a cooperating threaded member. The
15 powered loader may rotate the threaded member of the retainer relative to the threading on the syringe to engage the threading on the syringe and securely connect the syringe to the injector.

In general, many types of cooperating attachment members can be used for the mounting member and the retainer. The mounting member may, for example, include
20 a mounting flange or flanges (for example, a single annular flange or a plurality of flanges positioned about the circumference of a syringe or adapter) and the retainer may include a cooperating retaining flange or flanges. In this embodiment, the powered loader preferably moves the retainer to cause the retainer flange(s) to engage the mounting flange(s) to securely connect the syringe to the injector.

25 The injector may also include a loading or mounting sensor to determine when the syringe is in position for the powered loader to bring the mounting member and the retainer into secure engagement. The powered loading procedure can thereby be automatically initiated when the syringe is in position. The injector may also include one or more sensors to read information encoded upon the syringe. In another
30 embodiment, a single sensor can be used to both read encoded syringe information and to initiate the powered loading process.

The syringe (or an adapter that is attached to the rear of the syringe as described above) may include a generally annular flange preferably positioned forward of the mounting flange(s) that forms a sealing engagement with a forward surface of the retainer to assist in creating a secure engagement of the syringe to the injector and to assist in preventing leakage of fluids into the injector.

Preferably, the drive member or piston of the injector includes an engagement member on a forward end thereof. The engagement member is preferably adapted to connect or dock to the plunger upon forward advancement of the drive member. Preferably, the engagement member is suitable to connect to the plunger regardless of the axial position of the plunger within the syringe and regardless of the relative angular positions of the drive member and plunger about a generally common axis. Preferably, the drive member automatically connects to the plunger either during or shortly after the power loading or manual loading of the syringe onto the injector.

The drive member may, for example, be automatically advanced forward upon loading of the syringe on the injector to connect the drive member to the plunger. Whether the drive member is connected to the plunger automatically or by manual control, the injector preferably controls the motion of the drive member based upon syringe information encoded upon the syringe. For example, if the injector determines that the syringe is empty from the syringe information encoded upon the syringe, the injector preferably causes the drive member to advance the plunger forward to expel air from the syringe in preparation for loading the syringe with fluid. However, if the injector determines that the syringe is prefilled from the syringe information encoded upon the syringe, the injector preferably stops forward advancement of the drive member upon connection of the drive member with the plunger to prevent undesirable discharge of injection fluid from the prefilled syringe. Controlling the drive member, for example, to perform certain preinjection procedures in a manner that depends upon the type of syringe loaded upon the injector can save valuable user time and may help standardize injection procedures.

In another aspect, the present invention provides a system for injecting a liquid medium that includes a front-loading syringe for injecting a fluid into a patient and a powered injector. The syringe preferably includes an elongated body, a mounting member positioned on a rear portion of the body, and a plunger moveably positioned

within the body of the syringe. The injector preferably includes a housing having a front wall, and a retainer on the front wall that is adapted to retain the syringe on the front wall. The retainer preferably includes a powered loader adapted to bring the mounting member and the retainer into secure engagement to securely connect the syringe to the injector. The injector further includes a powered drive member in the housing that is adapted to engage the plunger and control the movement of the plunger.

In a further aspect, the present invention provides a method of connecting a front-loading syringe to a powered injector including the steps of positioning the syringe in a mounting position on the injector, and moving a retaining member of the injector in a powered manner to engage the syringe and connect the syringe to the injector.

In another aspect, the present invention provides a syringe for use with a powered injector. The syringe includes an elongated body, a plunger moveably positioned within the body of the syringe, and a threaded mounting member positioned on a rear portion of the syringe to retain the syringe on the injector. The syringe preferably further includes a stop member to prevent rotation of the syringe relative to a threaded retaining member of the injector when the threaded retaining member is rotated relative to the threaded mounting member to engage the threaded mounting member and connect the syringe to the injector.

In a further aspect, the present invention provides an injector for injecting a fluid from a syringe. The syringe includes an elongated body, a mounting member positioned on a rear portion of the body, a plunger moveably positioned within the body of the syringe, and encoded syringe information. The injector preferably includes a sensor to read the encoded syringe information, and a powered drive member adapted to engage the plunger and control the movement of the plunger. The drive member preferably controls the movement of the plunger in accordance with the encoded syringe information.

In still another aspect, the present invention provides a method of connecting a syringe to an injector for injection of a fluid into a patient. The syringe includes a plunger positioned therein and encoded syringe information. The method includes the steps of connecting the syringe to the injector, reading the syringe information, and

controlling the motion of the plunger in a manner that is dependent upon the encoded syringe information.

BRIEF DESCRIPTION OF THE DRAWINGS

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Other aspects of the invention and their advantages will be discerned from the following detailed description when read in connection with the accompanying drawings, in which:

Figure 1 illustrates a front perspective view of an embodiment of an injector system of the present invention;

Figure 2A illustrates a rear perspective view of an embodiment of a syringe and injector retainer of the present invention in a disassembled state;

Figure 2B illustrates perspective views of a syringe and an adapter of the present invention in a disassembled state;

Figure 2C illustrates perspective views of a syringe and an adapter of the present invention in a disassembled state;

Figure 3 illustrates a front perspective view of the syringe and retainer of Figure 2A in a disassembled state;

Figure 4A illustrates a side view of an embodiment of a plunger, retainer, piston and plunger release mechanism in which the piston is engaged by the plunger;

Figure 4B illustrates a side view of the plunger, retainer, piston and plunger release mechanism of Figure 4A in which the plunger release mechanism has been advanced to allow disengagement of the plunger from the piston;

Figure 4C illustrates a rear perspective view of the piston and plunger release mechanism of Figures 4A and 4B in a disassembled state;

Figure 4D illustrates a side view of the syringe, retainer and plunger release mechanism of Figures 4A-4C;

Figure 4E illustrates a cross-sectional view of an embodiment of a drive member including a sensor to detect plunger position;

Figure 5A illustrates a cross-sectional view of another embodiment of an injector system of the present invention in which the syringe is positioned for loading upon the injector; and

Figures 5B illustrates a cross-sectional view of the embodiment of Figure 5A in which the syringe is connected to the injector.

DETAILED DESCRIPTION OF THE INVENTION

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An embodiment of a front-loading injector system 10 of the present invention is illustrated in Figures 1 through 4D. Injector system 10 includes a syringe 100 and an injector 200. Injector housing 210 of injector 200 preferably includes a reciprocating piston 220 (see, for example, Figures 4A and 4C) therein which cooperates with a syringe plunger 110 disposed within an elongated cylindrical body 120 of syringe 100 to inject a fluid (for example, a contrast medium) from the interior of syringe 100 into a patient. Piston 220 is preferably extendible and retractable via a powered means as known in the art (not shown) that is preferably contained within injection housing 210 and includes, for example, a motor or hydraulic system, including appropriate gearing (not shown). As also known in the art, injector 200 also preferably includes a motor controller for controlling operation of a motor and thereby controlling operation of piston 220. The operation of injector 200 can, for example, be controlled by a computer 150 including a processing unit 152 and a memory 154.

As used herein to describe system 10, the terms "axial" or "axially" refer generally to an axis A around which system 10 (including, for example, piston 220 and syringe 10) is preferably formed (although not necessarily symmetrically therearound). The terms "proximal" or "rearward" refer generally to an axial direction toward the end of injector housing 210 opposite the end to which syringe 10 is mounted. The terms "distal" or "forward" refer generally to an axial direction toward a syringe tip 124 of syringe 10. The term "radial" refers generally to a direction normal to axis A.

Piston 220 moves axially forward and rearward through an interface 232 in a retainer 230 that includes a face plate 240 that is attached to or formed integrally with the front wall of housing 210. As illustrated in Figures 1 through 3, retainer 230 preferably further includes a generally annular retaining member 250 that rotatably seats in a seating area 234 in retainer 230. Retaining member 250 may, for example, include threading 252 on an inner surface thereof. Threading 252 cooperates with threading 130

positioned on a rearward portion of syringe body 120 to load and retain syringe 100 on injector 200.

As best shown in Figure 3, during loading of syringe 100 onto injector 200, an operator inserts the rear portion of syringe 100 within interface 232 in face plate 240 so that, for example, one or more guide or stop members 140 are aligned with
5 corresponding slot(s) 260 formed in face plate 240. Retainer 230 may include a sensor bank 264 (seated, for example, in seating area 266 formed in face plate 240) including a loading sensor or sensors 270 to detect the presence of syringe 100 and begin rotation of retaining member 250 to draw syringe 100 rearward within the interface in face
10 plate 240 and to create a secure engagement between syringe 100 and injector 200. Many types of sensors as known in the art can be used as loading sensor(s) 270. For example, loading sensor 270 can include a switch mechanism that is triggered by contact with stop member 140. Alternatively, a manual switch (not shown) located on injector 200 or remote therefrom can be used to begin rotation of retaining member 250
15 once syringe 100 is in position.

Figure 2B illustrates another embodiment of a syringe 100A that cooperates with an adapter 100B to connect to retainer. Adapter 100B preferably includes threading 130B, a guide or stop member 140B and a flange 160B that cooperate with retainer 230 as described above. Syringe 100A may, for example, be a syringe that connects to
20 adapter 100B in the manner described in U.S. Patent No. 5,383,858 for connecting a syringe to an injector. In that regard, adapter 100B includes retaining flanges (not shown) for receiving mounting flanges 102A on the rearward end of the syringe 100A. Syringe is manually rotated to engage the mounting flanges behind the associated or cooperating retaining flanges on the adapter. Use of an adapter such as
25 adapter 100B enables use of a wide variety of syringes with the retainers of the present invention. With use of an adaptor, many types of syringes can be used to take advantage of the benefits of the injectors of the present invention.

Similarly, syringe 100 can easily be adapted for use with other injectors through use of an adapter such as adapter 100C illustrated in Figure 2C.
30 Adapter 100C can, for example, be designed to adapt syringe 100 for use in current manually loaded injectors such as described in U.S. Patent No. 5,383,858, the contents of which are hereby incorporated by reference. In that regard, adapter 100C includes on

a rearward end thereof retaining flanges 102C that cooperate with the injector of U.S. Patent No. 5,383,858 as described therein. On a front end thereof, adapter 100C also includes an interface having a slot 140C on the perimeter thereof through which guide member 140 passes to allow threading 130 of syringe 100 to engage threading 130C of adapter 100C to connect syringe 100 to adapter 100C.

Sensor 270 or a manual switch as described above is preferably in communication with a power source such as an electric motor 300 so that motor 300 is switched on when syringe 100 is detected by sensor 270 or when an operator selects the manually operated loading switch. In the embodiment of Figures 1 through 4D, and as best shown in Figure 2A, motor 300 is in operative connection with a gear 310 that is rotatably seated within a seating area 280 within retainer 230 to mesh with an outer geared surface 254 of retaining member 250. Rotational motion of motor 300 is thus translated to rotation of rotating member 250. Abutment of stop member 140 with the sides of slot 260 (see Figure 3) prevents syringe 100 from rotating relative to retaining member 250 when retaining member 250 is rotated to engage syringe threading 130, thereby facilitating threaded engagement between retaining member 250 and syringe 100. Limit switches (not shown), position sensors (not shown) and/or measurement of motor current of motor 300 can, for example, be used to control movement of retaining member 250 to ensure that syringe 100A is properly loaded and excess stresses are not placed thereon.

Using cooperating threaded elements, syringe 100 can be loaded upon injector 200 in either a powered or manual manner. For example, if it is desirable to load syringe 100 onto injector 200 in a manual manner, retaining member 250 can be advanced to its forward position and held in that position. Syringe 100 can then be manually rotated to engage threading 130 with threading 252 of retaining member 250.

Syringe 100 preferably also includes a generally annular flange 160 positioned forward of threading 130. Flange 160 is preferably drawn securely against a portion of a front or forward surface of face plate 240 when syringe 100 is fully engaged within injector 200. Flange 160 assists in forming a secure interference fit between the syringe 100 and the injector 200, and also assists in preventing leakage of fluids into injector 200.

Upon secure connection of syringe 100 to injector 200 as described above (in either a powered or manual loading procedure), a preferably releasable connection between plunger 110 and piston 220 is preferably made. A number of manners of forming a releasable connection between a plunger and a piston in a front-loading injector system are disclosed in U.S. Patent Nos. 4,677,980, 5,383,858, 5,873,861 and 5,947,935, the disclosures of which are incorporated herein by reference. In the embodiment illustrated in Figures 4A through 4D, plunger 110 includes capture legs 112 that extend rearward from a rear surface of plunger 110. Capture legs 112 include radially inward extending abutment members 114 that cooperate with a radially outward extending flange 224 of a piston head 222 to releasably connect plunger 110 to piston 220. Capture legs 112 are cantilevered such that, when abutment members 114 are contacted by flange 224 upon forward advancement of piston 220 relative to plunger 110, capture legs 112 are forced radially outward to allow piston head 222 to pass therebetween. Capture legs 112 spring radially inward once flange 224 passes abutment members 114 so that abutment members 114 engage flange 224 to releasably connect plunger 110 to piston 220 as illustrated in Figure 4A. Flange 224 is preferably generally circular in shape so that the relative angular positions (as rotated about the common axis A shown in Figure 1) or orientation of plunger 110 and piston 220 are preferably unimportant to the ability to connect plunger 110 and piston 220.

In the embodiment of Figures 4A through 4D, plunger 110 is preferably released from piston 220 by forward advancement of a release cylinder 400 that contacts capture legs 112 to force capture legs radially outward as illustrated in Figure 4B. Piston 220 can then be drawn rearward to release plunger 110 from connection therewith. During operation of injector 200, release cylinder 400 is in a retracted position as illustrated in Figure 4A and travels generally in unison with piston 220, which is disposed within release cylinder 400. Upon, for example, completion of an injection procedure, an operator can preferably depress a release switch 212 on injector housing 210 to initiate release of plunger 110 (and, preferably, release of syringe 100 from injector 200). Upon depression of switch 212, a plunger release motor 410 is preferably activated to advance release cylinder 400 to release plunger 110.

Upon release of plunger 110 from piston 220 via release switch 212, syringe 100 can be released from injector 200 by simply activating retaining member 250 to

disconnect threading 252 thereof from threading 130 on the rear of syringe 100.

Preferably, such activation of retaining member 250 occurs automatically upon release of plunger 100. Upon disconnection, syringe 100 preferably remains releasably seated in interface 232 of retainer 230 until removed by the operator.

5 Depending, for example, upon the nature of syringe 100, and regardless of whether syringe 100 is loaded in a powered or manual manner, different operations may be performed upon connection of syringe 100 to injector 200. It is particularly advantageous to control and/or automate certain preinjection procedures. For example, in the case of an empty syringe, it may be desirable to advance plunger 110 within
10 syringe 100 to expel air therefrom and, subsequently, to draw injection fluid into syringe 100. One or more of these steps may be accomplished through manual control by an operator or automatically via, for example, control from computer 150.

 In the case of a prefilled syringe, on the other hand, after connection of syringe 100 to injector 200, caution should be exercised in advancing piston 220 any
15 farther forward than required to connect piston 220 to plunger 110. Excess forward motion of piston 110 will expel injection fluid from the prefilled syringe.

 Although the type of syringe connected to injector 200 can be determined by the operator, and the injector 200 programmed and controlled accordingly, it is also possible to have injector 200 detect the type of syringe 100, the contents thereof, the volume
20 thereof, etc. In that regard, one or more sensors 290 can be positioned on retainer 230 to detect syringe information that can be encoded on, for example, area 142 on syringe 100 (see Figure 3). Methods and systems for reading encoded syringe information are disclosed, for example, in U.S. Patent No. 5,383,858 and PCT Publication No. WO
25 99/65548, assigned to the Assignee of the present application, the disclosures of which are incorporated herein by reference. In one embodiment, sensors 270 and 290 may be combined in a single sensor.

 Moreover, in the case that a prefilled syringe is connected to injector 200, the engagement of syringe plunger 110 by the piston 220 may be detected by injector 200 to ensure that plunger 110 is not substantially advanced within the prefilled syringe,
30 thereby preventing the discharge of fluid therefrom. The detection of plunger position can be accomplished in numerous ways. For example, motor current in injector 200 can be measured. The greater resistance to advancement of piston 220 upon contact thereof

with plunger 110 can be sensed by measuring motor current, and the advancement of piston 220 subsequently stopped. Likewise, a sensor can be placed on piston head 222 and/or plunger 110 to detect contact of piston 220 with plunger 110. For example, plunger 110 can include a light source 116 and a light sensor 116' (see Figure 4B).

- 5 Connection of drive member 220 with plunger 110 will prevent light from light source 116 from reaching light sensor 116' and thereby provide an indication that connection has been made.

Figure 4E illustrates an alternative embodiment of a plunger 110' having capture members 112'. In this embodiment, plunger 110' includes a rearward projecting
10 element 114' that inserts into a passage 222' of a piston head 224' of a piston 220' upon connection of piston 220' and plunger 110'. Disposed on one side of passage 222' is a light source 226', and on an opposing side thereof is a light sensor 226". Connection of drive member 220' with plunger 110' will cause projecting element 114' to enter passage 222' and prevent light from light source 226' from reaching light sensor 226",
15 thereby providing an indication that connection has been made.

During loading of syringe 100 onto injector 200 as described above, an operator inserts the rear portion of syringe 100 within interface 232. Loading sensor(s) 270 detect the presence of syringe 100 and activate the motor 300 to begin loading syringe 100 upon injector 200. The type of syringe is sensed by sensor 290. Docking of
20 piston 220 to plunger 110, as described above, is preferably automatically initiated upon loading of syringe 100 into injector 200. If injector 200 senses that an empty syringe has been loaded thereupon, injector 200 preferably advances piston 220 to engage plunger 110. After engagement of plunger 110, piston 220 preferably continues to advance forward to expel air from syringe 100 and prepare syringe 100
25 for filling with injection fluid. Should injector 200 sense that a prefilled syringe has been loaded thereupon, however, piston 220 preferably engages plunger 110 and discontinues any further advancement until an injection procedure begins.

An alternative embodiment of a syringe mounting and retaining mechanism is illustrated in Figures 5A and 5B. In this embodiment, syringe 600 includes a generally
30 annular mounting flange 630 formed on a rearward portion thereof. Syringe 600 also includes a generally annular flange or sealing member 650 formed forward of mounting flange 630. Injector 700 includes a retainer 730 to securely connect

syringe 600 to injector 700. Retainer 730 includes, for example, a retaining member 750. Retaining member 750 preferably includes a plurality of capture members 752 that are preferably positioned around the circumference of retaining member 750. Each of capture members 752 preferably includes an abutment member 754 on a forward end thereof that is adapted to form a releasable connection with mounting flange 760.

Before loading of syringe 600 on injector 700, capture members 752 are in an open position as illustrated in Figure 5A in which capture members 752 are flared radially outward so that mounting flange 630 can pass by abutment members 754. Once syringe 600 is placed in loading position by an operator, retaining member 750 is drawn rearward, for example, via cooperation of threading 756 with a cooperating threaded member (not shown). As retaining member 750 is drawn rearward, the outer edges of capture members 752 contact a radially inward extending surface 732 of retainer 730, thereby drawing abutment members 754 radially inward to engage mounting flange 630.

After abutment members 754 engage mounting flange 630 and retainer 750 is drawn further rearward, syringe 600 is drawn rearward until flange 650 is drawn into engagement with a front surface of retainer 730 as illustrated in Figure 5B. Sensors (not shown) can be provided to ensure that engagement has been achieved. Capture members 752 and abutment members 754 are preferably forced radially inward by abutment with a beveled or chamfered surface 760 of retainer 730. Syringe 600 is thereby securely engaged within injector 700. To release syringe 600, retaining member 650 is moved forward so that capture members 752 are allowed to expand in a radial outward manner as illustrated in Figure 5A.

Although the present invention has been described in detail in connection with the above examples, it is to be understood that such detail is solely for that purpose and that variations can be made by those skilled in the art without departing from the scope of the invention as set forth in the following claims.

WHAT IS CLAIMED IS:

1. A syringe for use with an injector, the syringe comprising:
a body comprising a forward end and a rearward end; and
a plunger moveably disposed within the body;
characterized by
a mounting member disposed on the rearward end of the body for engaging a syringe retaining mechanism on the injector.
2. The syringe of claim 1 wherein the mounting member comprises an annular member adapted to be engaged by the syringe retaining mechanism.
3. The syringe of claim 1 wherein the mounting member comprises a threaded member adapted to be engaged by the syringe retaining mechanism.
4. The syringe of claim 3, further comprising a stop member adapted to prevent rotation of the syringe relative to the syringe retaining mechanism.
5. An injector for injecting a fluid from a syringe comprising a mounting member, the injector comprising:
a housing;
a piston disposed within the housing and adapted to engage a plunger of the syringe; and
a syringe retaining mechanism associated with the housing and adapted to cooperate with the mounting member of the syringe;
characterized by
a powered loader adapted to move the mounting member and the syringe retaining mechanism into engagement with one another to connect the syringe to the injector.

6. The injector of claim 5, further comprising a sensor adapted to detect when the syringe is in position for the powered loader to move the mounting member and the syringe retaining mechanism into engagement with one another.

7. The injector of claim 5 wherein the syringe retaining mechanism comprises a threading.

8. The injector of claim 5 wherein the syringe retaining mechanism comprises a flange.

9. The injector of claim 5 wherein the piston comprises an engagement member on a forward end thereof, the engagement member adapted to connect to the plunger upon forward advancement of the drive member.

10. The injector of claim 5 wherein the piston is automatically advanced to engage the plunger upon connection of the syringe to the injector.

11. The injector of claim 10, further comprising a sensor adapted to read syringe information encoded upon the syringe.

12. The injector of claim 11 wherein the motion of the piston is controlled based upon the syringe information encoded upon the syringe and read by the sensor.

13. The injector of claim 11 wherein the piston advances the plunger forward to expel air from the syringe based on the syringe information read by the sensor.

14. The injector of claim 11 wherein the forward motion of the piston is stopped upon engagement with the plunger based upon the syringe information read by the sensor.

15. An injector system comprising the syringe of claims 1-4 and the injector of claims 5-14.

16. A method of connecting a syringe to an injector. the method comprising:

positioning the syringe within an interface associated with the injector; and
moving a syringe retaining mechanism of the injector to engage a mounting member of the syringe.

17. The method of claim 16, further comprising:
reading syringe information encoded on the syringe; and
controlling the motion of a piston of the injector based upon the encoded syringe information

18. The method of claim 17, further comprising the step of advancing a plunger of the syringe to expel air from the syringe.

19. The method of claim 17, further comprising the step of advancing the piston into engagement with a plunger of the syringe.

20. A syringe adapter for use with an injector. the syringe adapter comprising:

a rear mounting member adapted to engage a syringe retaining mechanism associated with the injector; and

a front mounting member adapted to engage a corresponding mounting member associated with a syringe to install the syringe on the injector.

21. The syringe adapter of claim 20 wherein the rear mounting member comprises an annular member adapted to be engaged by the syringe retaining mechanism.

22. The syringe adapter of claim 20 wherein the rear mounting member comprises a threaded member adapted to be engaged by the syringe retaining mechanism.

23. The syringe adapter of claim 22, further comprising a stop member adapted to prevent rotation of the syringe adapter relative to the syringe retaining mechanism.

24. An injector for injecting a fluid from a syringe providing encoded syringe information, the injector comprising:

a sensor adapted to read the encoded syringe information; and

a piston adapted to engage a plunger of the syringe;

characterized in that

the injector is adapted to control the movement of the piston based upon the encoded syringe information.

25. The injector of claim 24 wherein the piston comprises an engagement member on a forward end thereof, the engagement member adapted to connect to the plunger upon advancement of the piston.

26. The injector of claim 24 wherein the piston is automatically advanced to engage the plunger upon connection of the syringe on the injector.

27. The injector of claim 24 wherein the piston advances the plunger forward to expel air from the syringe based on the syringe information read by the sensor.

28. The injector of claim 24 wherein advancement of the piston is stopped upon engagement with the plunger based upon the syringe information read by the sensor.

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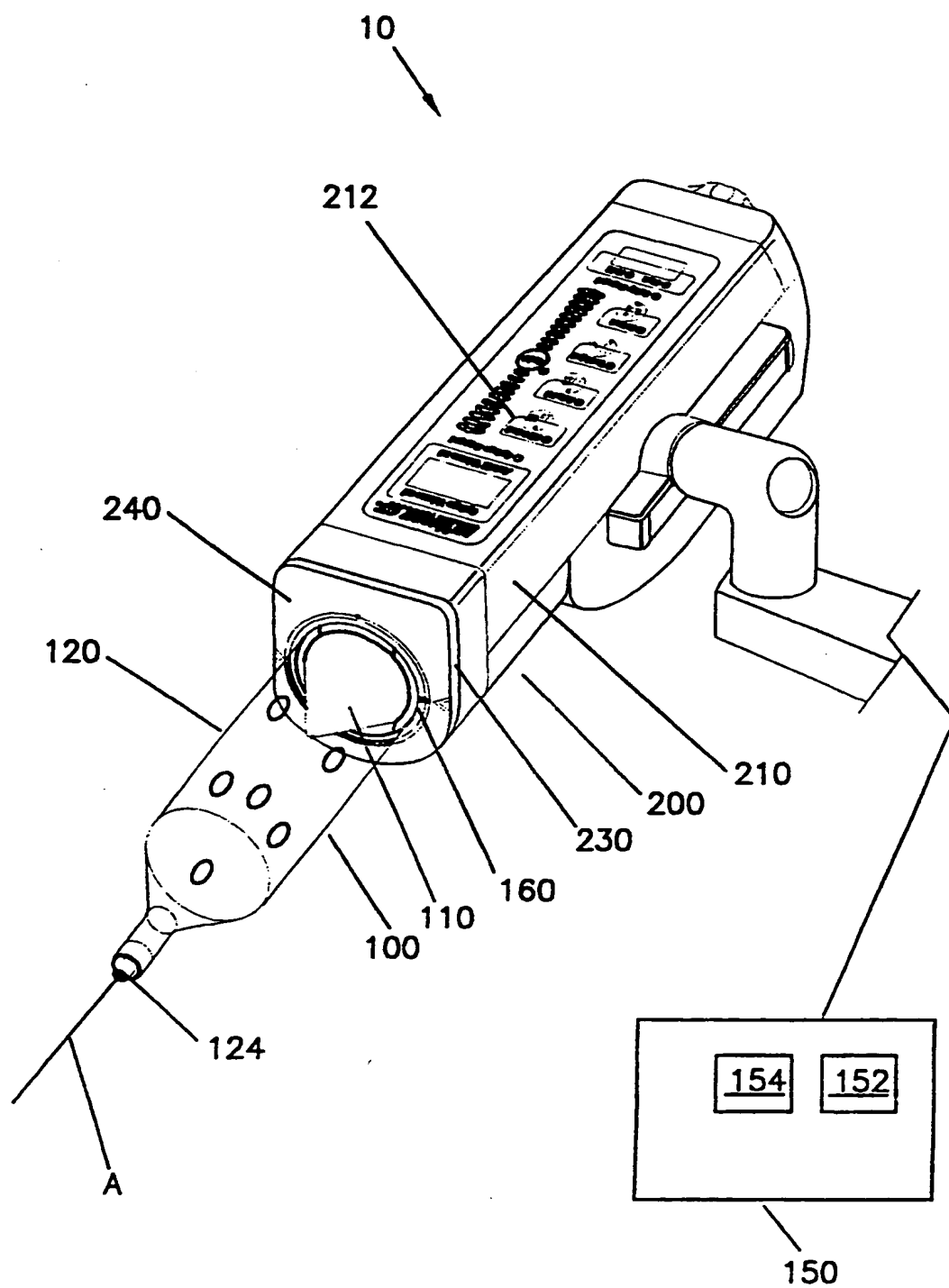


FIG. 1

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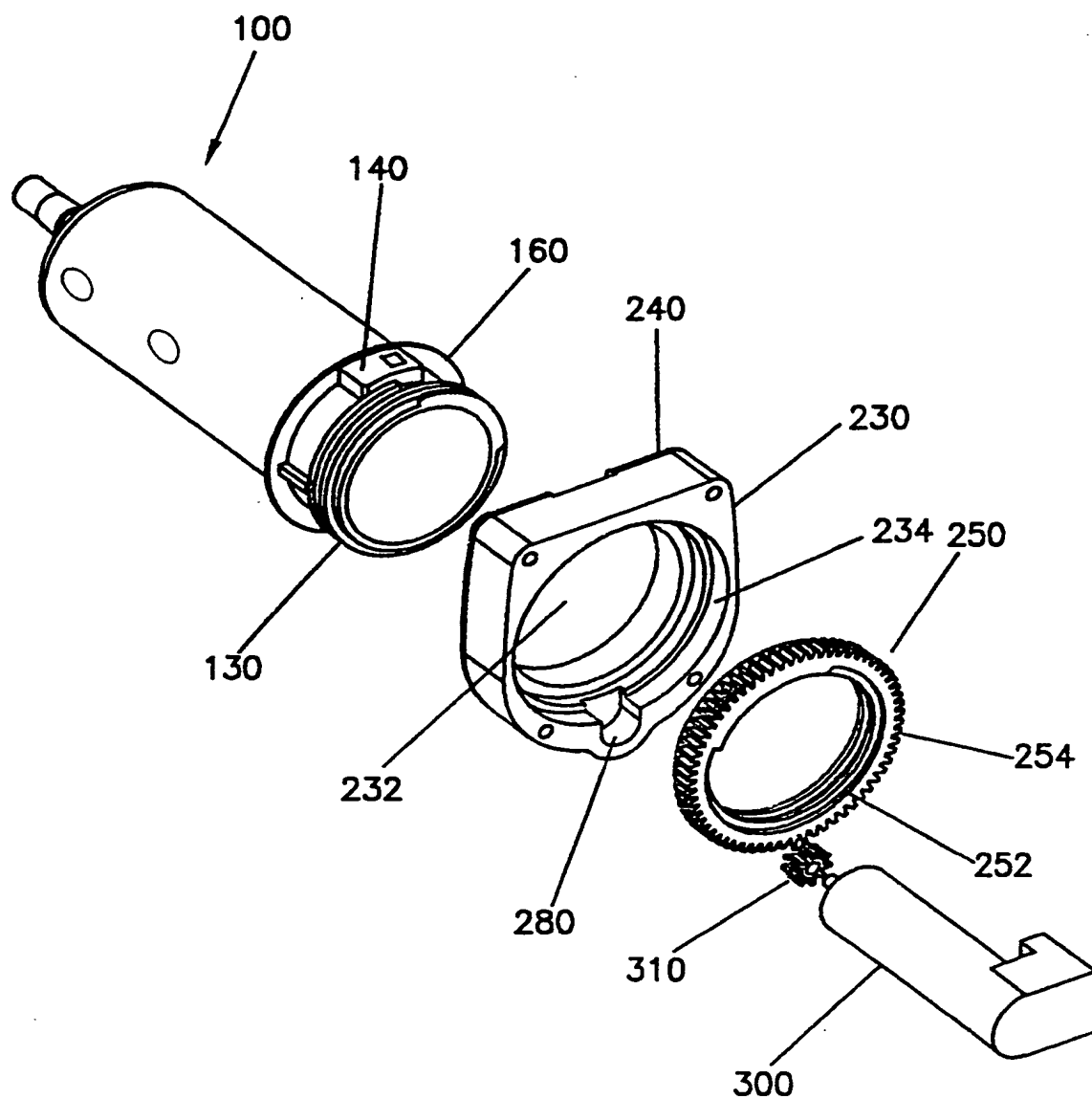
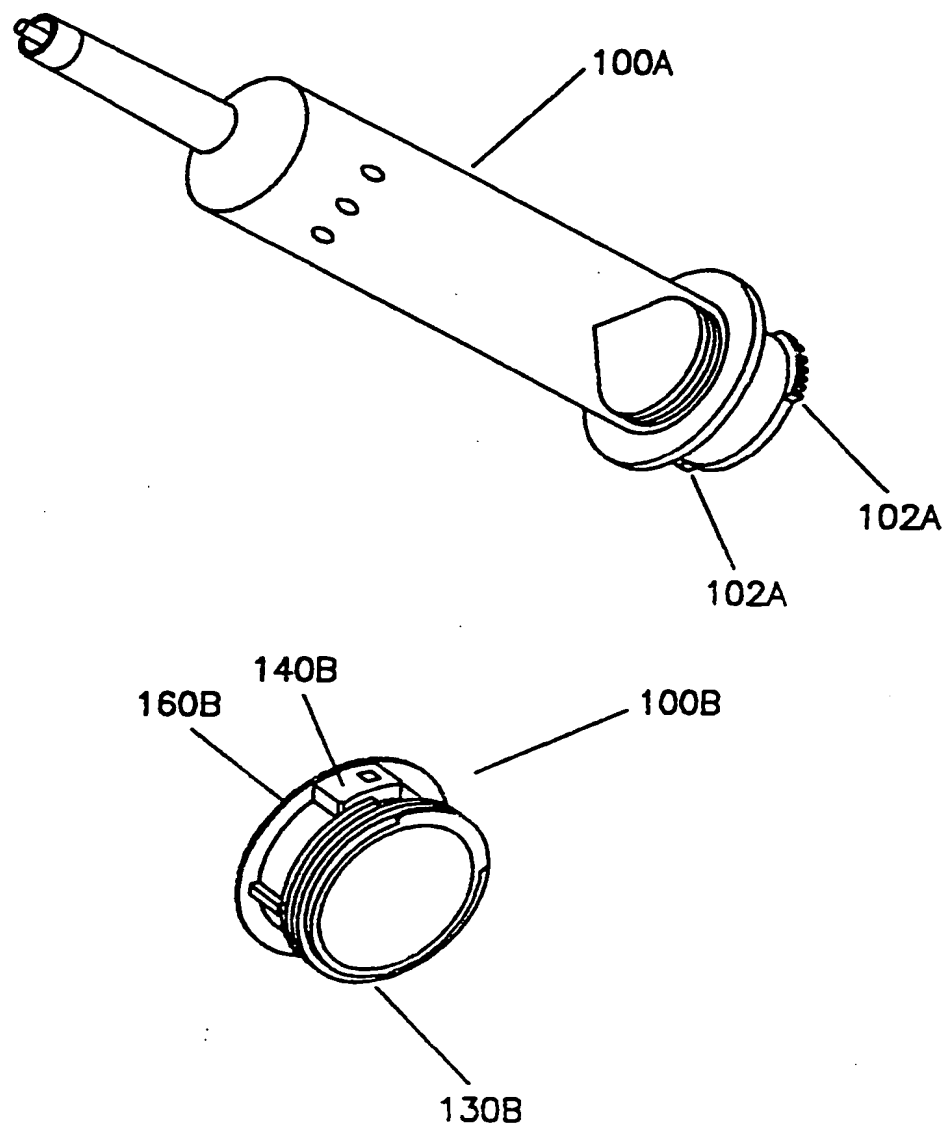


FIG. 2A

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FIG. 2B



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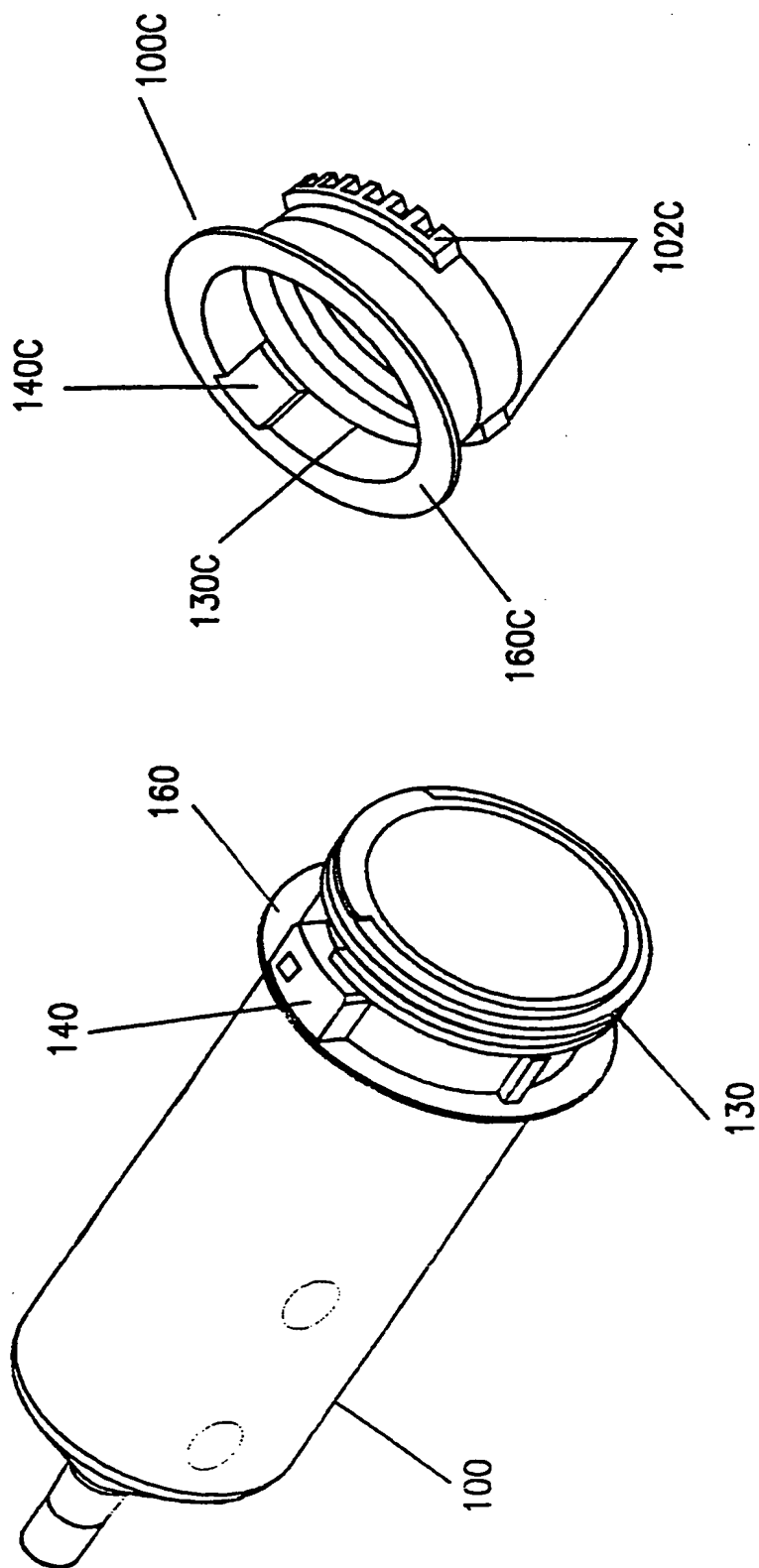


FIG. 2C

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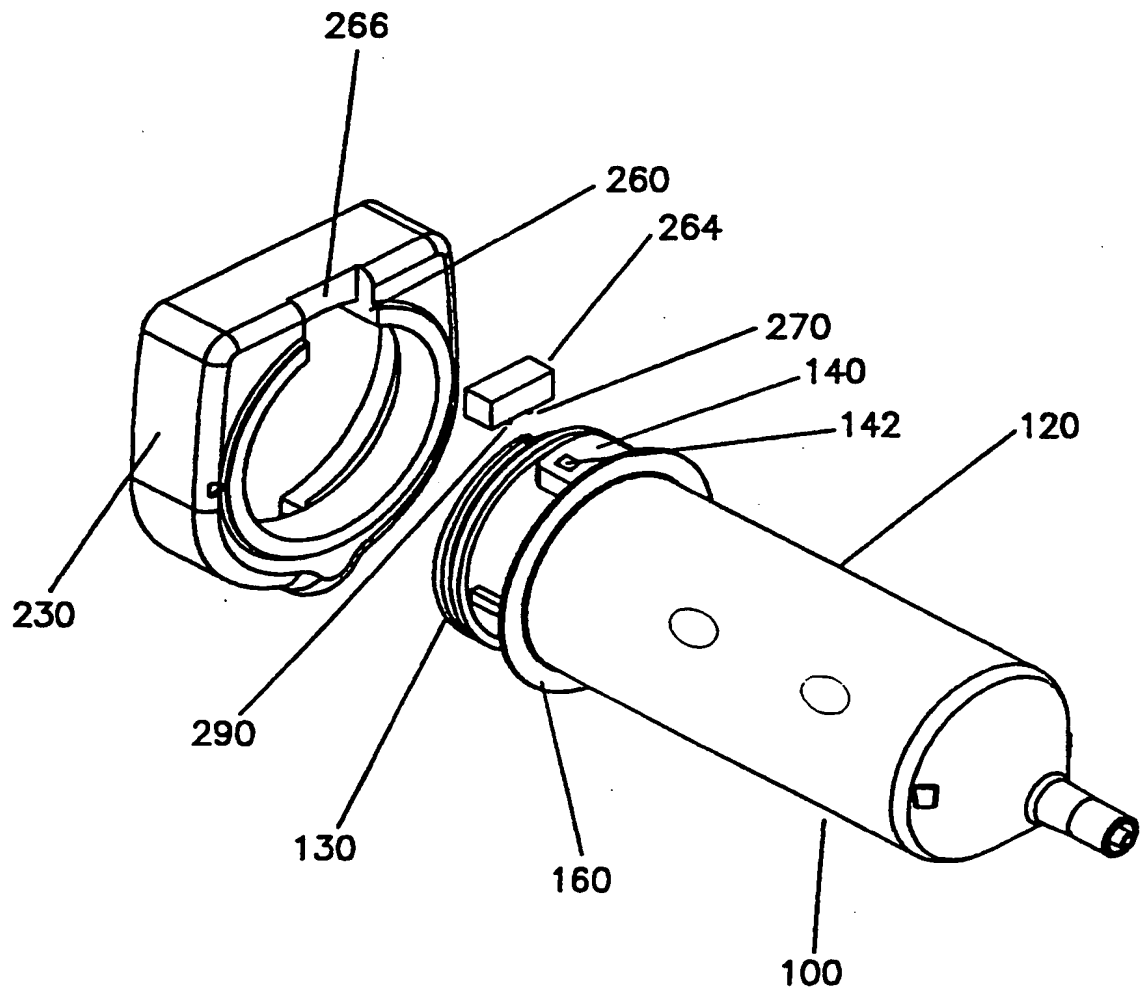
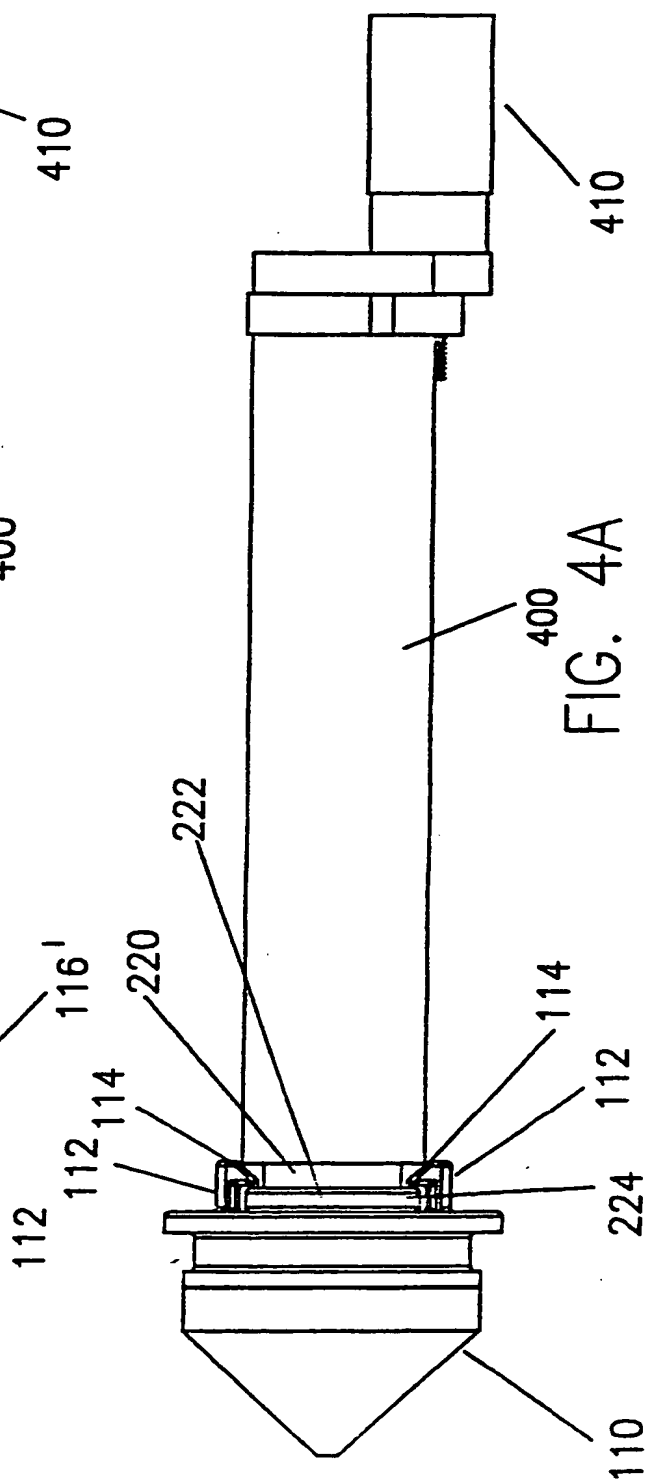
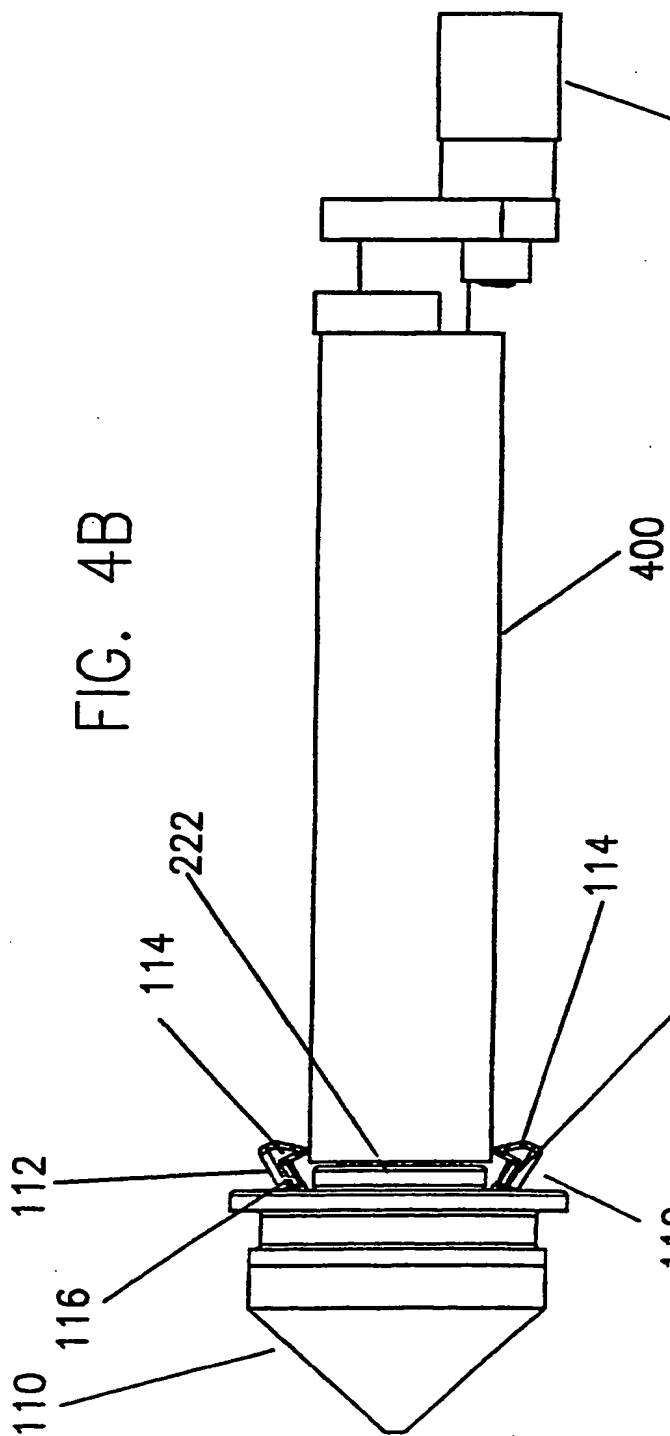


FIG. 3

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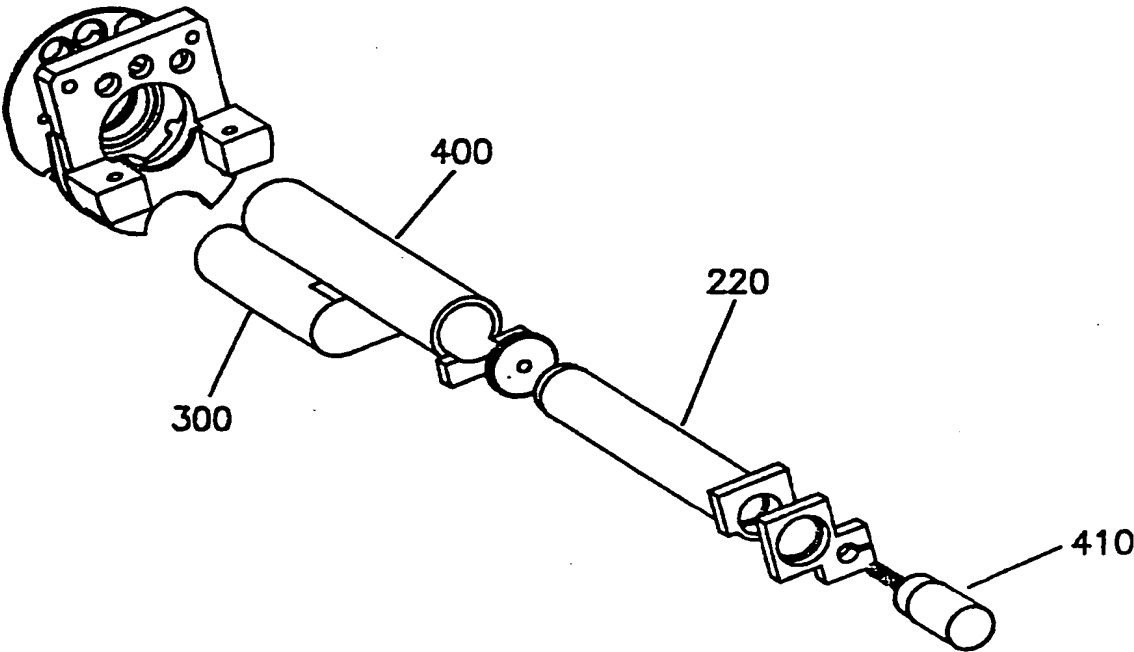


FIG. 4C

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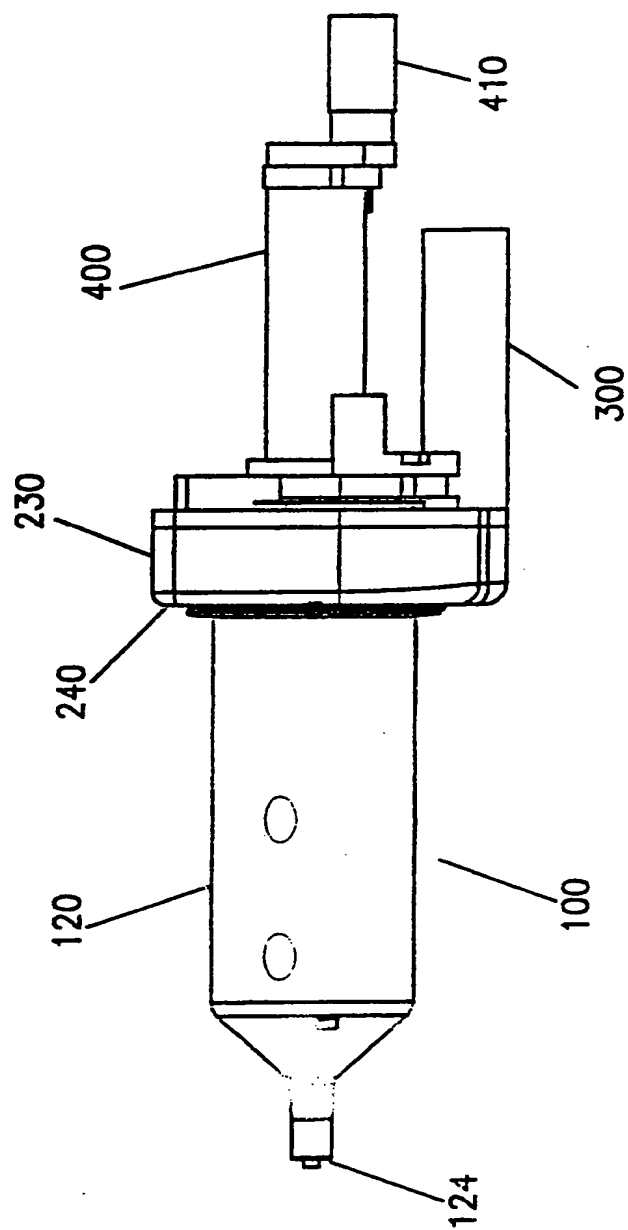


FIG. 4D

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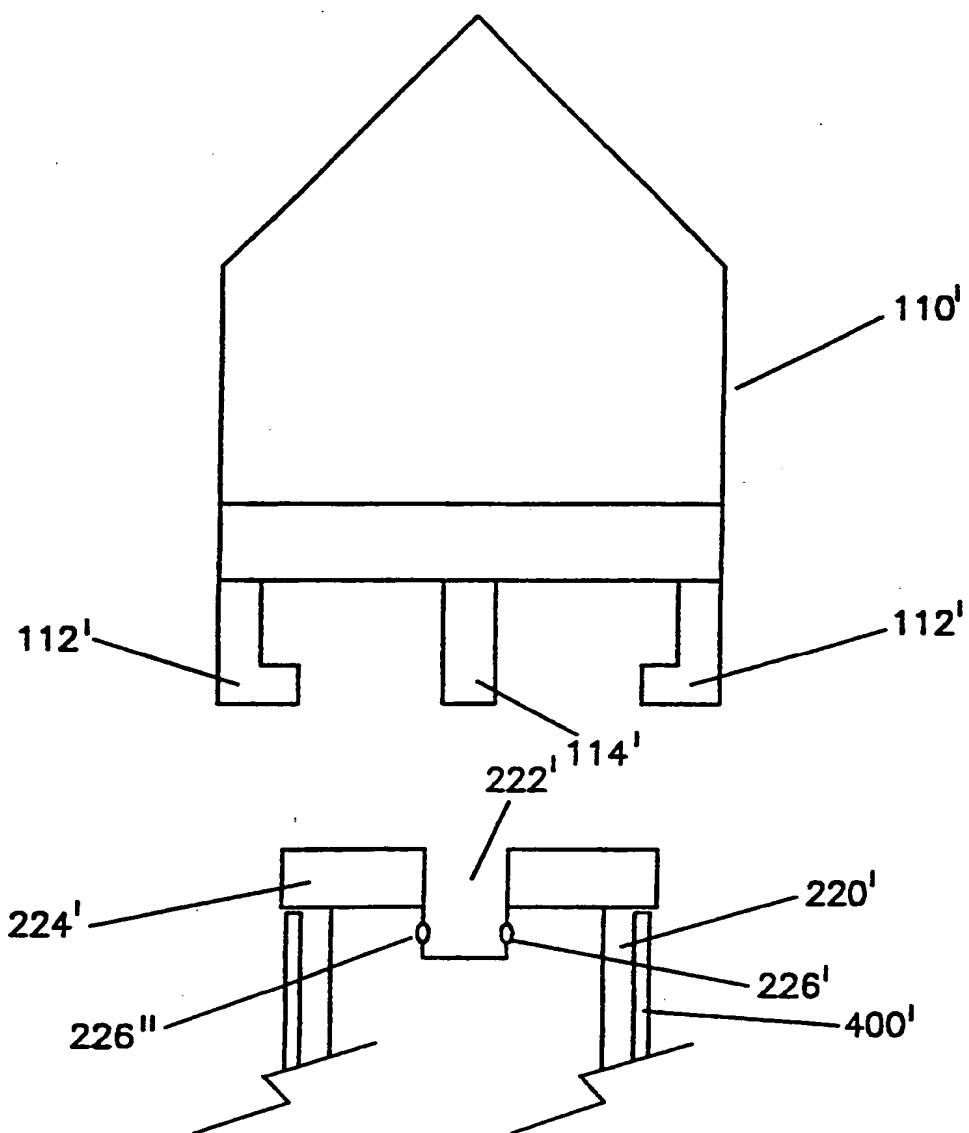


FIG. 4E

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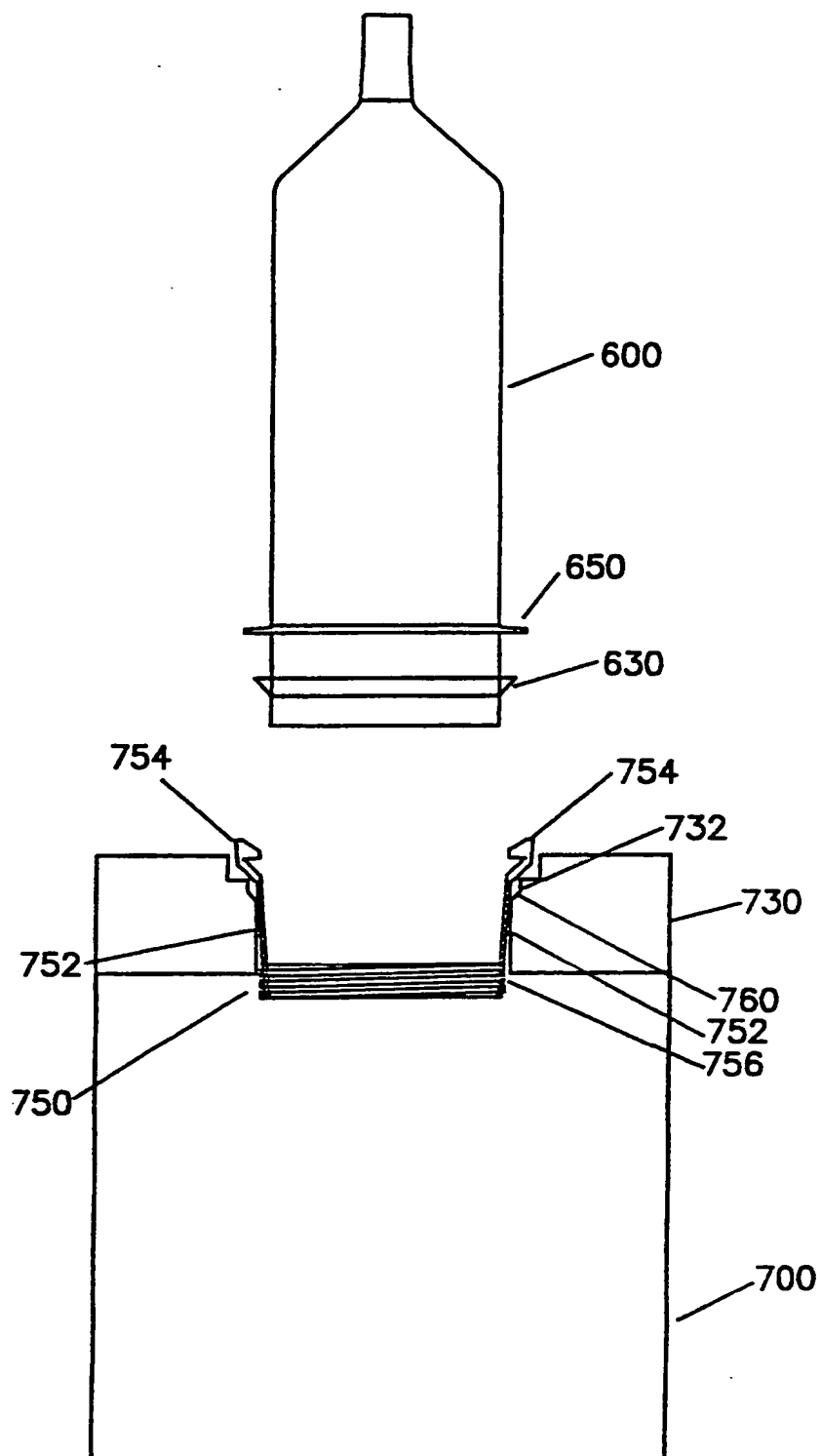


FIG. 5A

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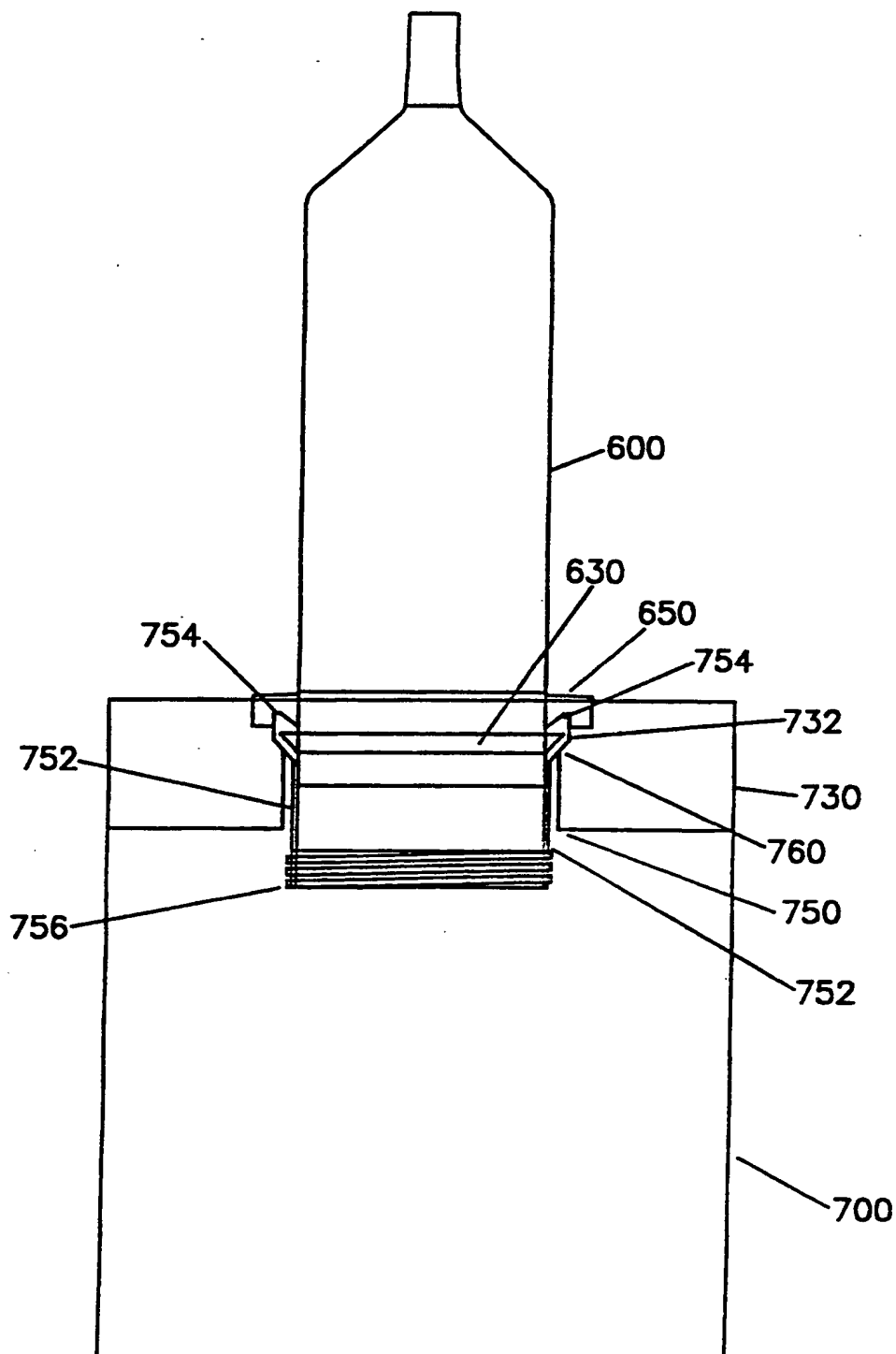


FIG. 5B

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
31 May 2001 (31.05.2001)

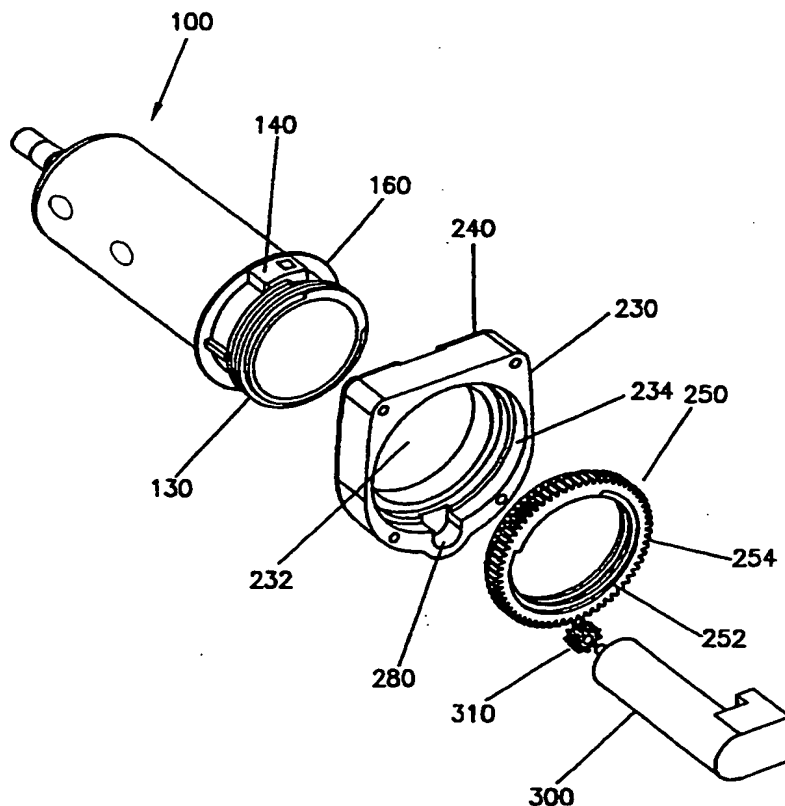
PCT

(10) International Publication Number
WO 01/37905 A3

- (51) International Patent Classification⁷: **A61M 5/145** (74) Agent: **BRADLEY, Gregory, L.**; Medrad, Inc., One Medrad Drive, Indianola, PA 15051 (US).
- (21) International Application Number: **PCT/US00/32271**
- (22) International Filing Date:
21 November 2000 (21.11.2000)
- (25) Filing Language: **English**
- (26) Publication Language: **English**
- (30) Priority Data:
09/448,835 24 November 1999 (24.11.1999) **US**
- (71) Applicant: **MEDRAD, INC.** [US/US]; One Medrad Drive, Indianola, PA 15051 (US).
- (72) Inventor: **REILLY, David, M.**; 2318 Middle Road, Glenshaw, PA 15116 (US).
- (81) Designated States (*national*): AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.
- (84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).
- Published:
— with international search report

[Continued on next page]

(54) Title: **INJECTORS, INJECTOR SYSTEMS, SYRINGES AND METHODS OF CONNECTING A SYRINGE TO AN INJECTOR**



(57) Abstract: A syringe includes an elongated body, a mounting member positioned on a rear portion of the body, and a plunger moveably positioned within the body of the syringe. An injector includes a housing and a retainer associated therewith. The retainer is adapted to cooperate with the mounting member to releasably retain the syringe on the injector. The retainer preferably includes a powered loader adapted to move the mounting member and the retainer into engagement to securely connect the syringe to the injector. The injector further includes a powered drive member disposed in the housing. The drive member is adapted to engage and control the movement of the plunger.

WO 01/37905 A3



(88) Date of publication of the international search report:
17 January 2002

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 00/32271

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61M5/145

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A61M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 919 167 A (VANROYEN DONALD F ET AL) 6 July 1999 (1999-07-06) column 5, line 16 - line 20 figures	1-3,16
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X	EP 0 749 757 A (LIEBEL FLARSHEIM CO) 27 December 1996 (1996-12-27) column 3, line 43 - line 45 column 13, line 12 - line 50 figures	16,20
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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

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Date of the actual completion of the international search

9 March 2001

Date of mailing of the international search report

03.07.2001

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

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INTERNATIONAL SEARCH REPORT

Int. Application No
PCT/US 00/32271

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 944 694 A (HITCHINS MARK W ET AL) 31 August 1999 (1999-08-31) column 10, line 10 - line 22 column 10, line 63 -column 11, line 3 figure 5	11
A	--- EP 0 346 950 A (MEDRAD INC) 20 December 1989 (1989-12-20) figures 17,20 -----	9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 00/32271

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of Item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-4, 5-15, 16-19, 20-23

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-4, 5-15, 16-19, 20-23

1.1. Claims: 1-4

Syringe comprising a mounting member

Claims 5-15:

Injector having a housing, a piston, a syringe retaining mechanism and a power loader

Claims 16-19:

Method of connecting a syringe to an injector

1.2. Claims: 20-23

Syringe adapter for use with an injector having a rear mounting member and a front mounting member

2. Claims: 24-28

Injector having a sensor suitable for reading encoded syringe information, a piston and means to control the movement of the piston based upon the encoded syringe information

Please note that all inventions mentioned under item 1, although not necessarily linked by a common inventive concept, could be searched without effort justifying an additional fee.

INTERNATIONAL SEARCH REPORT

Information on patent family members

Int. .ational Application No

PCT/US 00/32271

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